Technical note

Sacro-iliac joint arthroscopy for arthrodesis after traumatic dislocation. Cadaver and clinical feasibility study

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Abstract

Background: Sacro-iliac arthrodesis usually requires an extended posterior approach, which is associated with a number of dreaded complications. Here, we assessed the feasibility of arthroscopic exploration of the dislocated sacro-iliac joint.

Materials and methods: In the first step of our study, we used ligament section to induce loss of sacro-iliac joint coaptation in a cadaver. We then studied 5 patients with Tile C pelvic ring injuries. Arthroscopy was used to clear the joint of fibrous tissue and to roughen the bone to subchondral level in order to induce sacro-iliac arthrodesis. In addition, posterior fixation was performed using a hinge system or an ilio-sacral screw.

Results: The cadaver study confirmed the feasibility of sacro-iliac arthroscopy after disruption of the strong posterior inter-osseous ligament. In the clinical part of the study in 5 patients with Tile C pelvic ring injuries, arthroscopy allowed direct visualisation extending to the anterior part of the joint space. A power burr and synovial knife were introduced to remove the interposed fibrous tissue and to roughen the bone to subchondral level in order to induce joint fusion. In addition, percutaneous or open posterior fixation was performed in all 5 patients. No infectious complications were recorded.

Discussion: An arthroscope cannot be introduced into the normal sacro-iliac joint. In contrast, after traumatic sacro-iliac dislocation, arthroscopy can be used to evaluate the intra-articular injuries and to roughen the bone to subchondral level.

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1. Introduction

The normal sacro-iliac joint cannot be explored by arthroscopy, as the joint space is too tight to allow the introduction of an arthroscope. The sacro-iliac joint is a diarthrosis\textsuperscript{[1]} whose stabilisation by strong ligaments results in a chiefly static role of torso weight transfer to the lower limbs\textsuperscript{[2]}. A number of injuries can affect the congruence of the sacro-iliac joint. Examples include sacro-iliac joint dislocation combined with injury to the pubic symphysis or obturator ring\textsuperscript{[3]}.

No indexed publications describe the use of arthroscopy in the management of sacro-iliac joint injuries.

Here, our objectives were to assess the feasibility of sacro-iliac joint arthroscopy in a cadaver and to report our clinical experience with the use of arthroscopy to induce sacro-iliac joint fusion in 5 patients.

2. Cadaver study

2.1. Study subject

We studied both sacro-iliac joints of the embalmed cadaver of a 72-year-old woman at the pathology institute of the Rennes School of Medicine, Rennes, France. The cadaver showed no evidence of pelvic ring lesions. Each sacro-iliac joint was assessed according to a pre-defined procedure.

2.2. Operative technique

A small incision centred on the pubic symphysis was performed and the symphysis was divided using a scalpel and an osteotome. The right sacro-iliac joint was then approached via an anterior ilio-inguinal approach, with the cadaver in the supine position. The ilio-psas muscle overlying the joint was retracted laterally,
whereas the iliac vessels and lumbo-sacral trunk were retracted medially. A scalpel was used to sever the anterior capsule and ligaments. Then, a wide osteotome was slipped into the joint space to separate the two joint surfaces, thus, replicating a severe anterior sprain. An endoscope was used to explore the space thus created between the two joint surfaces. The objective was to reach and divide the posterior capsule and ligaments (posterior inter-osseous ligament). Via this intra-pelvic approach, two 2-mm Kirschner wires were advanced in the anterior-to-posterior direction within the space thus created, one at the cranial pole and the other at the caudal pole of the joint. The cadaver was turned in lateral decubitus and the wires were advanced through the posterior sacro-iliac ligaments, muscles, and dorsal skin. With the cadaver turned back to the supine position, these wires indicated the boundaries and orientation of the sacro-iliac joint (Fig. 1).

The same technique was used to approach the left sacro-iliac joint. The anterior capsule and ligaments were severed and the joint space opened using the osteotome. However, the posterior inter-osseous ligament was left intact.

The first step of the posterior approach to the right sacro-iliac joint consisted in creating an arthroscopic portal and an instrumental portal whose entry sites were located between the two wires. The direction of the wires provided guidance for advancing a 30° arthroscope and, subsequently, a burr or synovial knife (Fig. 1).

The directions used on the right side were replicated on the left side to attempt a percutaneous approach to the joint whose posterior capsule and ligaments (posterior inter-osseous ligament) were intact. Should this attempt fail, an open approach was to be performed to cut the posterior capsule and ligaments.

2.3. Results

During anterior arthroscopy of the right sacro-iliac joint, the sacral and iliac cartilage surfaces were visualised. The posterior capsule and ligaments were visible and palpable and were cut using a synovial knife.

The right sacro-iliac joint was successfully accessed via the posterior percutaneous approach guided by the wires introduced during the anterior step (Fig. 1). The wires determined the arthroscope entry site located 2.5 cm from the bulge of the S1 spinous process. The entry lines parallel to the wires diverged by 60° towards the joint. Both joint surfaces and the anterior capsule and ligament lesions were visible. A burr and a synovial knife were introduced under arthroscopic guidance.

Accessing the left sacro-iliac joint via the posterior percutaneous approach proved impossible. An open approach was needed to cut the strong posterior sacro-iliac ligaments. An osteotome was introduced to further separate the joint surfaces. An arthroscope was then successfully introduced and used to guide the arthroscopic instruments and to visualise the anterior joint areas.

3. Clinical study

Arthroscopy of the sacro-iliac joint via the posterior approach was performed to achieve arthrodesis of the joint in 5 patients.

3.1. Patients

We studied 4 males and 1 female with pelvic ring injuries. Mean age was 36.8 years. The cause of injury was a fall from a height in 2 cases and a horseback riding, motor vehicle, and farm accident in 1 case each. In 4 patients, the injuries were managed at the acute phase, 6.3 days on average after the accident. The remaining patient had a chronic lesion that was treated after 19 months. All 5 patients had Tile C pelvic ring injuries [4] documented by computed tomography (CT) and characterised by sacro-iliac joint dislocation combined with either pubic symphysis separation or a fracture of the obturator ring [5] (Fig. 2).

3.2. Operative technique

The patient was in the prone position on a radiolucent table without traction. Pads were placed under the chest and pelvis to open up the abdomen and induce slight flexion of the hips. No traction was used during the procedure.

The first step consisted in attempting to introduce an arthroscope cannula percutaneously into the joint space. The entry site was 2.5 cm from the midline. The direction of the cannula was determined based on posterior iliac crest palpation and on a plane inclined laterally and anteriorly at an angle of about 60° relative to the sagittal plane. Within this plane, the direction of the arthroscope could vary in the cranio-caudal direction depending on the area to be explored. Fluoroscopy was used to check instrument position (Fig. 3).

Then, a midline incision centred on the lumbo-sacral junction was performed to allow screw insertion into the pedicles of L5, S1, and S2. The subcutaneous space was then opened above the fascia to the posterior iliac crest, where the erector spinae muscle was partially detached. This “buttonhole” technique [5] resulted in lateral extension of the access to the sacro-iliac joint (Fig. 4).
The joint was then accessible to the introduction, via an open approach, of two rigid cannulas. The arthroscopic portal and instrumental portal could complement each other, and switching between the two was possible in the cranio-caudal direction.

Exploration of the joint started with an assessment of the joint surfaces, capsule, and anterior ligaments, using a palpating hook. Then, the cartilaginous areas were abraded using burrs or synovial knives. A cortical-cancellous bone graft was introduced and its placement within the joint space was guided arthroscopically.

Finally, additional sacro-iliac joint fixation was performed using a hinge system [6]. Two sacral screws inserted into the pedicles of S1 and S2 were placed on a rod. The rod linking the two sacral screws carried two connectors at different levels that were linked to two iliac extension screws (Fig. 5) (Legacy® 5.5, Minneapolis, MN, USA). Alternatively, percutaneous ilio-sacral screw insertion under fluoroscopic guidance could have been used [7].

At each step of the arthroscopic exploration, the visualised anatomic structures were recorded. Whether arthroscopy was
performed, percutaneously or via an open approach, was noted also. The feasibility of introducing and using a synovial knife and burr was evaluated.

3.3. Results

The four acute injuries were managed according to the above-described protocol. The separation of the sacro-iliac joint surfaces, documented by CT (Fig. 2), allowed the introduction of arthroscopic instruments, documentation of the anterior ligament lesions, and abrasion of the cartilage surfaces (Fig. 6). When the open approach was used, direct curetting was feasible, but the use of arthroscopy provided optimal guidance in the zones that were difficult to access.

The arthroscope was introduced via the open approach in the first patient and percutaneously in the next 3 patients. Additional anterior fixation of the pubis symphysis was performed in 3 patients (Fig. 7). This step was not carried out in the fourth patient, as reduction via the posterior approach was of good quality and the presence of a supra-pubic bladder catheter increased the risk of infection.

In the patient with a chronic injury, the procedure started with an arthroscopic exploration via a posterior percutaneous approach. A synovial knife was used to remove the large amount of soft fibrous tissue present within the joint space. A burr was then introduced to abrade the joint surfaces. In this patient with chronic instability, an additional 2-cm approach allowed the introduction into the joint space of a cancellous bone graft, harvested from the contralateral posterior iliac crest. Fixation was achieved using a transverse ilio-sacral screw inserted under fluoroscopic guidance (Fig. 7).

In this small case-series, no neurological, haemorrhagic, or septic complications were recorded.

4. Discussion

4.1. Functional and traumatological anatomy of the sacro-iliac joint

The sacro-iliac joint consists of two condyles separated by a saddle-shaped surface [8]. The anterior and posterior segments have different orientations that form a $140^\circ$ angle open anteriorly [2] (Fig. 8). This configuration explains the difficulties raised by the introduction of an arthroscope into the joint space under normal conditions.


Cadaver studies involving exploration and section of the anterior and posterior sacro-iliac ligaments have established that the posterior structures are the strongest [2]. Our findings in a cadaver suggest that injury to the posterior ligaments may be a prerequisite to feasibility of sacro-iliac joint arthroscopy.

Thus, loss of joint coaptation due to capsule and ligament lesions can allow alignment of the two joint segments, although their orientations are normally different in the sagittal plane.

4.2. Technical considerations and applications

The degree of difficulty experienced in introducing the arthroscope depends on the degree of joint surface separation. The angles defined during the cadaver study, together with palpation of the bony landmarks, provide guidance for introduction of the instruments.

Joint surface abrasion using burrs and synovial knives under visual guidance is designed to optimise joint fusion. The
fibro-cartilaginous tissues must be removed to promote joint fusion.

When a posterior hinge system is used for posterior sacro-iliac joint fixation, an open approach is mandatory. A curette can then easily be introduced into the joint. However, despite the loss of joint surface coaptation, the anterior part of the joint can be visualised only through an arthroscope.

When percutaneous ilio-sacral screw fixation is performed, arthroscopic joint surface abrasion can improve the likelihood of joint fusion while preserving the minimally invasive nature of the procedure. Arthroscopy also serves to guide the introduction and positioning of a cancellous bone graft.

Biomechanical studies have established that either ilio-sacral screw fixation or posterior hinge fixation effectively stabilises Tile C pelvic ring injuries, provided anterior fixation of the pelvic ring is performed also [7,9,10]. Our strategy involves posterior fixation before anterior fixation, as the persistence after posterior hinge fixation of mobility in the horizontal plane theoretically allows the reduction of residual pubic symphysis separation [5]. In one of our patients, isolated posterior fixation was used for stabilisation. This patient had a supra-pubic bladder catheter with suppurration of the cutaneous entry site. Given the good quality reduction achieved after the posterior step, we decided not to perform anterior fixation, in order to minimise the risk of surgical site infection.

4.3. Indications

Arthroscopy used as a complement to posterior ilio-sacral fixation has a role in optimising joint surface abrasion.

We used this technique in patients with Tile C pelvic ring injuries [5]. We believe it is indicated only when the sacro-iliac joint injuries are confined to the ligaments and not when the posterior instability is due to a sacral fracture. We also used our technique in a patient with chronic instability who was seen at a distance from the trauma.

Arthroscopic access was obtained percutaneously in 4 of our 5 patients. The remaining patient was our first case, and the failure was probably ascribable to inexperience.

Percutaneous arthroscopy to perform minimally invasive arthrodesis combined with ilio-sacral screw fixation is feasible. This strategy may find its best indication when the instability is moderate, as in our patient with chronic lesions. Additional cancellous bone grafting can be achieved by adding a short posterior approach.

4.4. Limitations

Our conclusions are limited by the small number of patients in our case-series. However, this small sample size indicates that the learning curve is short. The benefits of arthroscopic joint surface abrasion have not been documented. However, the objective of this study was to evaluate the feasibility of the technique.

5. Conclusion

Arthroscopy of the sacro-iliac joint is feasible in patients with traumatic dislocation of the joint. Arthroscopic guidance of joint surface abrasion, most notably at the anterior part of the joint space, is feasible during arthrodesis procedures.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References